Thermal model for smectite illitization in the Alava Through (Basque-Cantabrian basin. Spain)

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Temperature is one of the kinetic factors that more attention has received in studies of diagenetic prograde reactions, such as smectite illitization. However a direct correspondence between temperature and illitization is not possible due to the influence of other factors; comparisons between different basins based on temperature can only be made if the other variables are equivalent. Most research dealing with relationships between smectite illitization and burial temperature has focused on sandstones and shales, with the carbonate sediments receiving very little attention.

The aim of this study has been to elaborate a burial and thermal approach model, for a well (Castillo-5) representative of the Alava Through in the Basque-Cantabrian basin (Spain) that allows to obtain the thresholds of temperature for the smectite illitization stages, in a carbonated scenario. The studied series is a thick sequence of sediments (more than 5000 m) without major tectonic overprint.

Smectite illitization in this well may be monitored with increasing depth, by means of the prograde zones:

- R0, defined by the presence of randomly smectite-rich mixed-layer I/S.
- R1, with illite-rich ordered I/S (R1/R3 > 1) and no randomly smectite-rich mixed-layers.
- R3, with illite-rich ordered I/S (R1/R3 < 1) and poorly crystallized illite (PCI).

Their limits are not coincident with a lithostratigraphic change and therefore they must be a consequence of post-depositional changes, related to burial diagenesis.

We have constructed a thermal model by means of successive iterations of thermal flow around the most common values for basins in similar geodynamic settings. The validity of the assumed thermal history has been verified by 2 calibration parameters: the corrected bottom hole temperature (BHT) and available vitrinite reflectance data.

Disappearance of smectite defines the lower limit of R0 zone and took place at a maximum temperature of 160ºC. The transition between zones R1-R3 corresponds to 240ºC and the complete disappearance of R1 I/S around 270ºC. These values are higher than those described in the bibliography. The scarcity of K-bearing phases and the low permeability, typical features of marls and limestones, explain the observed delay.

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